

# Pediatric Cochlear Implantation: candidacy and outcomes for non- traditional candidates

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# Disclosures

## Audiology Advisory Board

- Advanced Bionics
- Cochlear Americas
  - MED-EL

# Pediatric Cochlear Implant Criteria

- based primarily on the audiogram and auditory progress
  - varies with age\*
- each manufacturer outlines *slightly* different criteria
- Labeled indications have not been modified for 15 years.

# Current CI criteria for children

Manufacturer	Advanced Bionics (AB)	Cochlear	MED-EL
Hearing loss	Profound bilateral SNHL (> 90 dB HL)	<p><u>&lt; 2 years</u>: Profound bilateral SNHL (&gt; 90 dB HL)</p> <p><u>2+ years</u>: severe-to-profound bilateral SNHL</p>	profound, bilateral SNHL (90+ dB HL at 1000 Hz)
Speech recognition (older children)	<p><u>&lt; 4 years</u>: &lt; 20% correct simple open-set words (e.g., MLNT)</p> <p><u>&gt; 4 years</u>: &lt; 12% on for difficult open-set words (i.e. PB-K) or &lt; 30% on open-set sentences (e.g., HINT-C)</p>	≤ 30% correct word recognition MLNT or LNT	< 20% correct word recognition for MLNT or LNT

# Lack of auditory progress with HAs: younger children

**AB, Cochlear & MED-EL:** little to no progress with  
appropriately fitted HAs

Package inserts: 3- to 6-month trial with HAs

e.g., IT-MAIS, MAIS

# Lack of auditory progress with HAs: older children

**AB:** < 12% word recognition (PBK) or < 30%  
HINT-C sentence recognition

**Cochlear:**  $\leq$  30% word recognition (MLNT or LNT)

**MED-EL:** < 20% word recognition (MLNT or LNT)

**Children must miss 70 to 88% of the  
signal to qualify!**

# **Evidence for the expansion of pediatric cochlear implant candidacy**



## Evidence for the Expansion of Pediatric Cochlear Implant Candidacy

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**Objective:** To test the hypothesis that children who are non-traditional cochlear implant candidates, but are not making progress with appropriately fitted hearing aids and intervention, will demonstrate significant benefit from cochlear implantation as defined by improvement in (1) speech perception, (2) auditory skills development, and/or (3) progress on standardized measures of receptive and expressive language.

**Study Design:** Retrospective case series.

**Setting:** Two tertiary academic cochlear implant centers.

**Patients:** All pediatric patients that underwent cochlear implantation were reviewed. Only those meeting one or both of the following criteria were included: (1) less severe hearing loss than specified in the current indications and (2) open-set word

and standardized norm-referenced estimates of speech and language development.

**Results:** A total of 51 patients met study criteria. The mean age at time of surgery was 8.3 years and 24% underwent bilateral sequential implantation. Overall, the mean speech recognition improvement was 63 percentage points in the implanted ear ( $p < 0.001$ ) and 40 percentage points in the bimodal condition ( $p < 0.001$ ). Results of auditory and language development measures revealed significant improvement after implantation ( $p < 0.05$ ).

**Conclusion:** Non-traditional pediatric implant recipients derive significant benefit from cochlear implantation. A large-scale reassessment of pediatric cochlear implant candidacy, including less severe hearing losses and higher preoperative speech recog-



**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

**HYPOTHESIS:** Children who are non-traditional CI candidates, but are not making progress with appropriately fitted HAs and intervention will demonstrate significant benefit from cochlear implantation as defined by improvement in:

- 1) Speech perception and/or
- 2) Auditory skill development

**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

## **Study inclusion criteria**

CI recipients < 18 years of age with cochlear SNHL and one or both of the following:

- **< 70 dB HL PTA** for children between 2 and 17 years of age or **< 90 dB HL PTA** for those under 24 months
- Age appropriate word and/or sentence recognition scores **> 30%** in the best-aided condition for children who are able to reliably participate in speech perception testing with recorded stimuli

**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

## **Primary outcome measures**

Pre- & post-CI results for age appropriate materials:

- Speech recognition tests in the CI ear, contralateral ear and best-aided conditions
  - NUCHIPs, MLNT, LNT, CNC
  - HINT-C, BabyBio, AzBio
- Parental questionnaires gauging auditory skills development
  - IT-MAIS/MAIS, LittleEARS, PEACH

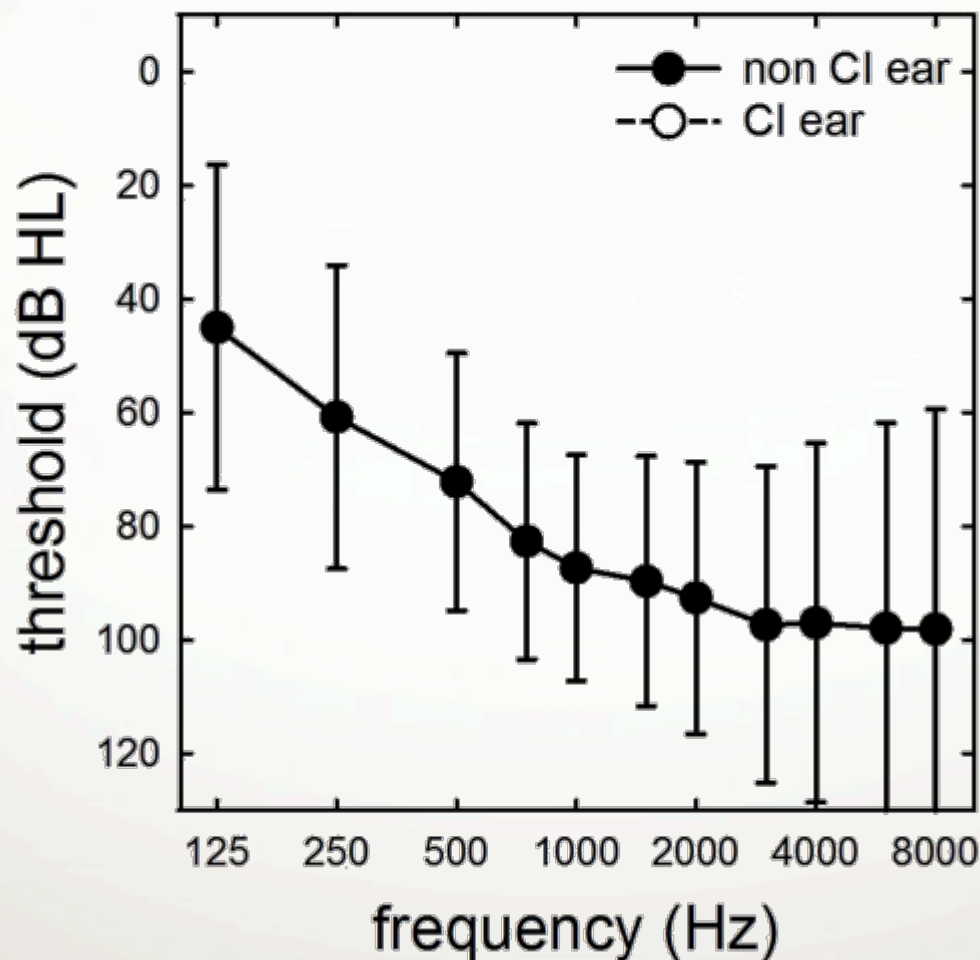
## **Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

### **Participants**

- 51 patients (across 2 centers)
  - 39 unilateral, 12 bilateral
- Mean age of implantation: 8.3 years
  - Range: 7.0 months to 17.6 years
- Mean duration of CI experience at reported follow-up: 17.1 months
  - Range: 2.5 to 46.5 months
- All were implanted with the most recent technology
  - AB: 13 ears
  - Cochlear: 44 ears
  - MED-EL: 6 ears

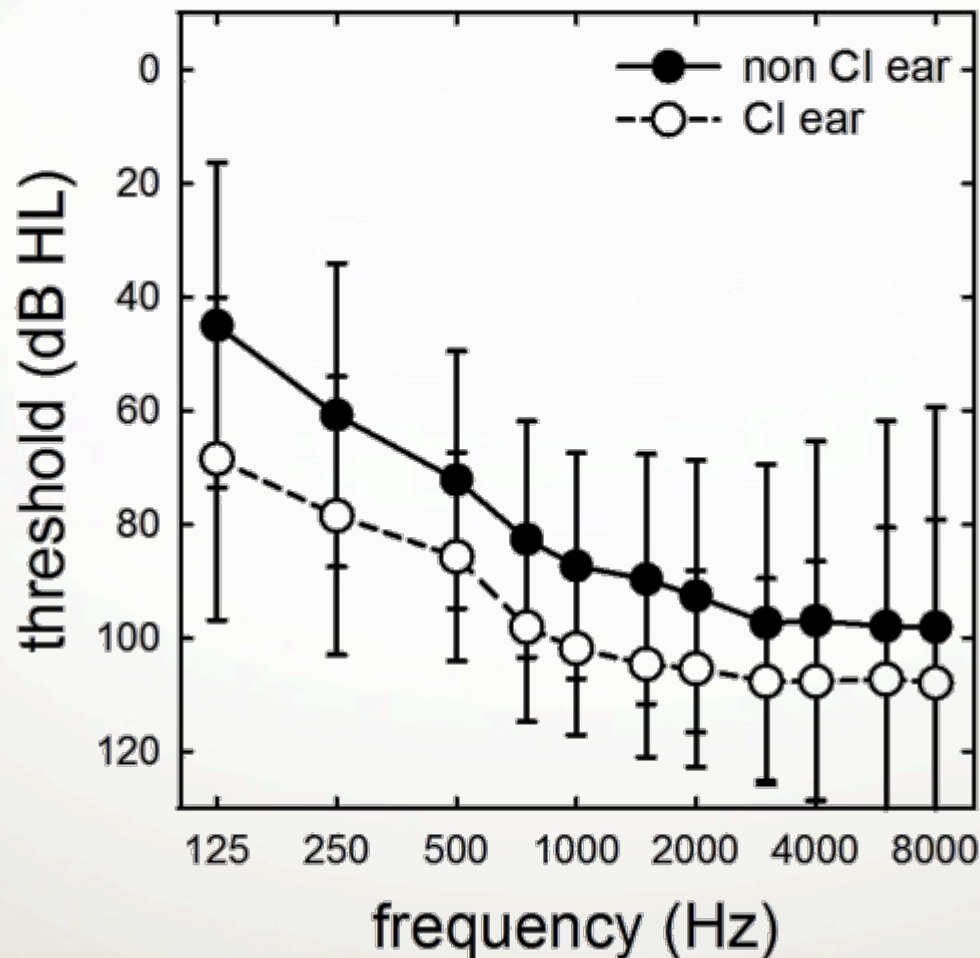
**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

## Participants



**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

## Participants



**Carlson et al. (2015). Otol Neurotol. 36(1):43-50.**

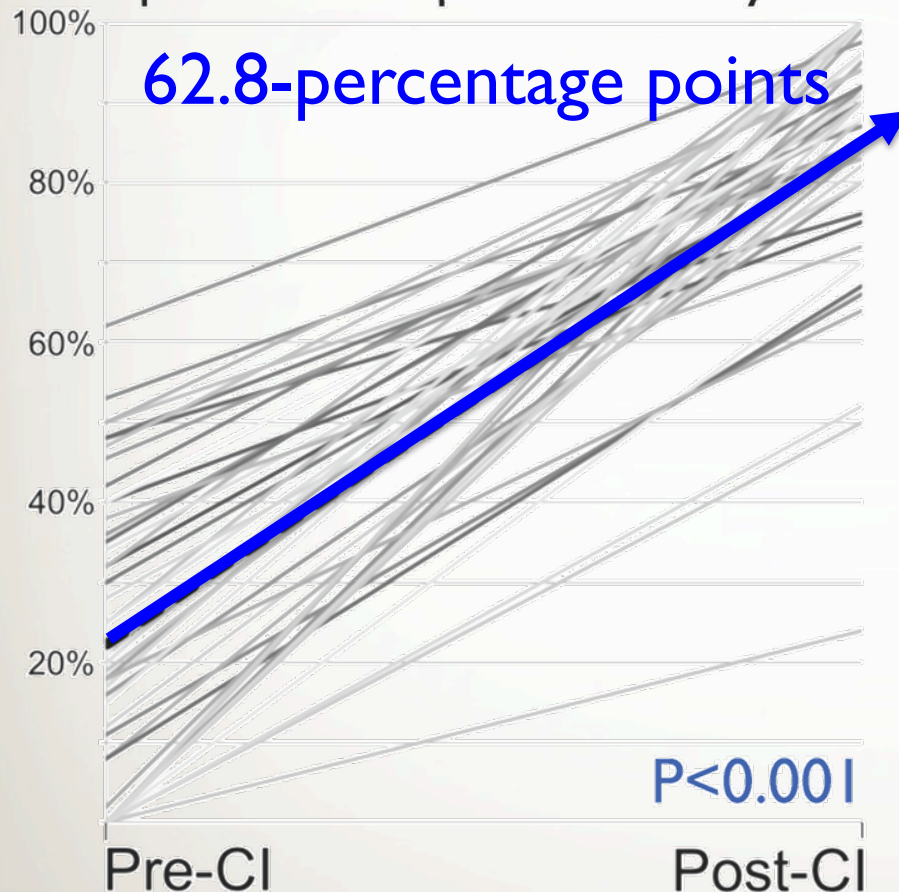
## **Speech perception testing**



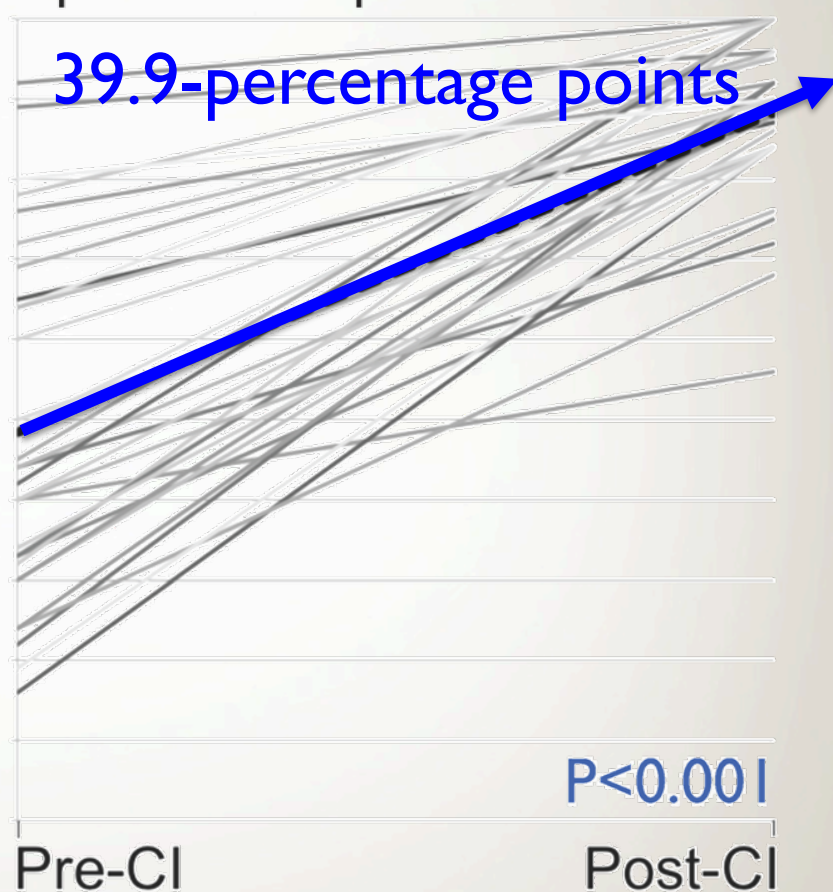


## Carlson et al. (2015). Otol Neurotol. 36(1):43-50.

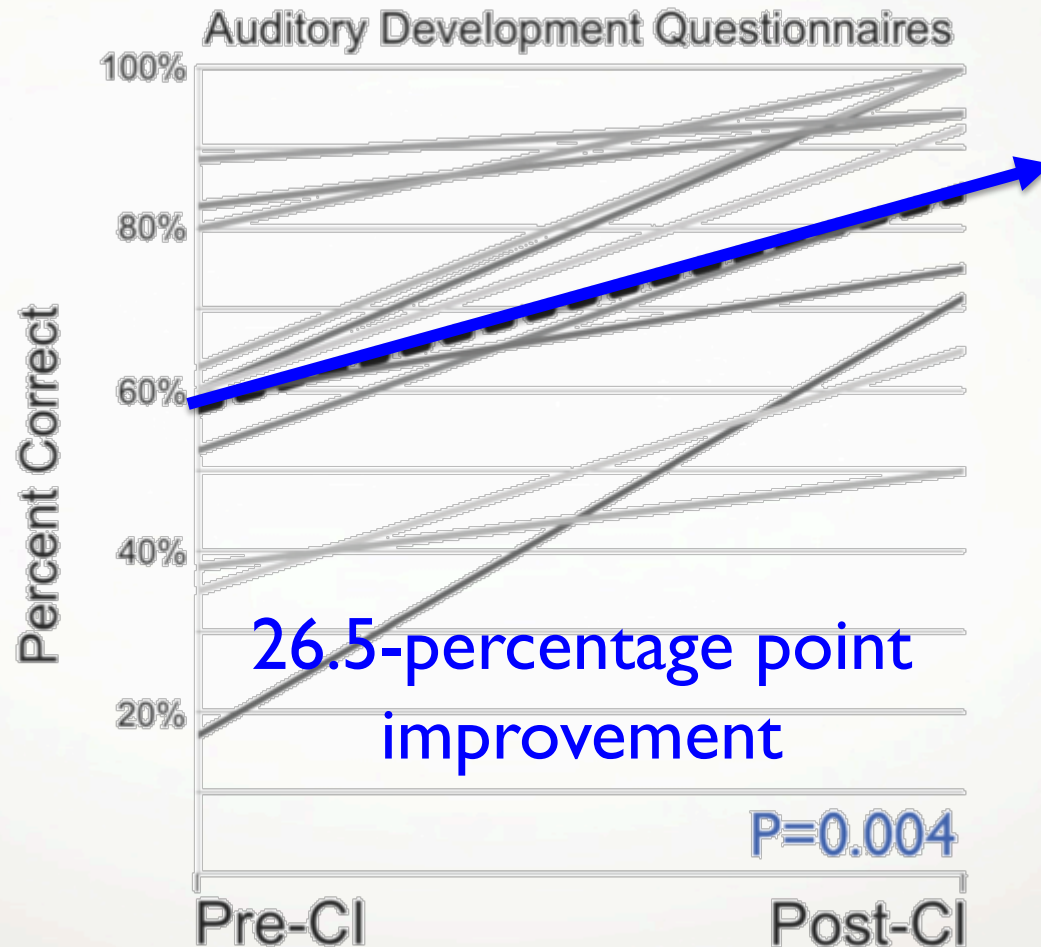
Speech Perception CI Only



Speech Perception Bimodal



## Carlson et al. (2015). Otol Neurotol. 36(1):43-50.



## **Other studies documenting significant benefit for non-traditional pediatric CI candidates**

Dettman et al. (2004) Arch Otolaryngol Head Neck Surg, 130: 612-8.

Fitzpatrick et al (2006). BMC Ear Nose Throat Disord. 19:6-7.

Fitzpatrick et al. (2009). Int J Audiol, 48: 91-7.

Cadieux et al. (2013). Otol Neurotol, 34:408-15.

Hassepass et al. (2013). Otol Neurotol, 34: 53-60.

## STUDY CONCLUSIONS

- Children with greater degrees of residual hearing than are specified by current FDA labeling, gain significant benefit from CI
- CI should be considered for children with SNHL who 1) make full-time use of appropriately fitted hearing aids, 2) comply with Rx therapy & intervention, 3) but who are NOT making month-for-month progress for auditory, speech, and language skills
- A large-scale reassessment of peds CI candidacy is warranted to allow more children access to the benefits of CI

# Implanting children under 12 months of age

## Audiometric criteria for pediatric CI are:

- most stringent for youngest children
- our youngest language learners



# Pediatric Cochlear Implant Criteria

- Infants can link sound patterns with meaning by 6 months (e.g., mommy, daddy, no, bye bye, etc.)
  - Tincoff & Jusczyk (1999). *Psychol Sci.* 10: 172-175.
- Word segmentation abilities develop rapidly between 7.5 and 12 months
  - Jusczyk et al. (1999). *Cogn Psychol*, 39: 159-207.
  - Bortfeld et al. (2005). *Psychol Sci.* 16: 298-304.
  - Seidl & Johnson (2008). *J Child Lang.* 35: 1-24.
- 8-month olds: long-term word storage—up to 2 weeks
  - Jusczyk & Hohne (1997). *Science.* 277(5334): 1984-1986.



# Pediatric Cochlear Implant Criteria

- children implanted < 12 months have significantly better:
  - word learning
    - Houston & Miyamoto (2010). Otol Neurotol. 31:1248-53.
    - Houston et al. (2012). Dev Sci. 15:448-61
  - expressive and/or total language
    - Tomblin et al. (2005). J Speech Lang Hear Res, 48: 853-67.
    - Nicholas & Geers (2013). Otol Neurotol, 34: 532-8.
    - Cuda et al. (2014). Int J Ped Otorhinolaryngol. 78:1327-31.
    - Tobey et al. (2013). Int J Audiol, 52: 219-29.
    - Holman et al. (2013). Otol Neurotol, 34: 251-8.
  - speech perception
    - Tajudeen et al. (2010). 31:1254-60.

Age matters!  
But current CI criteria are  
strictest for the youngest  
children.

# CONCLUSIONS

- current labeled indications for children are restrictive with respect to :
  - severity
  - symmetry
  - age
    - language learning opportunities missed in the 1<sup>st</sup> year of life
    - impacts later outcomes
  - speech understanding
    - required to miss 70 to 88% of the signal
    - in the *quiet* sound booth.



**Thank you for your attention.**

